To what extent is the elevated risk of psychological distress in people with diabetes accounted for by physical disability? Findings from a large population-based study

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ABSTRACT

Objectives People with diabetes experience an elevated risk of psychological distress compared with people without diabetes. It is unclear how much of this elevated risk is attributable to the greater levels of physical disability in people with diabetes, and how this risk varies according to sociodemographic and health-behavioural characteristics. This study quantified levels of psychological distress in people with and without diabetes, considering these factors.

Design Cross-sectional analysis of questionnaire data.

Setting Men and women aged ≥45 years, in the 45 and Up Study, from New South Wales, Australia.

Participants 236 441 people who completed the baseline postal questionnaire (distributed from 1 January 2006–31 December 2008), with valid data for diabetes status and psychological distress.

Primary outcome measures High psychological distress (Kessler-10 >22). Modified Poisson regression with robust error variance was used to estimate prevalence ratios (PRs), comparing prevalence of high psychological distress among those with and without diabetes and across physical functional limitation (PFL) levels, adjusting for potential confounders.

Results Overall, 8.4% (19 803/236 441) of participants reported diabetes. 11.8% (2339) of individuals with diabetes and 7.2% (15 664) without diabetes had high psychological distress: age-adjusted and sex-adjusted PR=1.89 (95% CI 1.81 to 1.97), becoming 1.58 (1.52 to 1.65) and 1.22 (1.17 to 1.27) following additional adjustment for sociodemographic factors, health behaviours and additionally for PFL, respectively. Compared with individuals with neither diabetes nor PFL, the adjusted PRs for high psychological distress were: 1.37 (1.17 to 1.60) with diabetes but no PFL, 7.33 (7.00 to 7.67) without diabetes but with severe PFL and 8.89 (8.36 to 9.46) with both diabetes and severe PFL.

Conclusions People with diabetes have a 60% greater risk of high psychological distress than people without diabetes; a substantial proportion of this elevation is attributable to higher levels of disability with diabetes, especially factoring in measurement error. Psychological distress is strongly related to physical impairment.

Strengths and limitations of this study

► The cohort study used for estimating all-cause mortality risk, the 45 and Up Study, is large and population-based, and the wide range of health data collected from the study population has allowed for multiple variables to be adjusted for.
► The study questionnaire used validated measures of psychological distress and physical functional limitations which ensured the reliability of the data.
► Prevalence ratios of high psychological distress, comparing those with and without diabetes, stratified by level of PFL and need for help with daily tasks were estimated to investigate how much of any observed relationship could be attributed to disability.
► Study limitations include the use of diabetes status determined using self-report. However, a previous study has shown both high sensitivity and specificity for self-reported diabetes in this population, with 98% of true cases being correctly identified.
► The use of a cross-sectional design meant that neither the causality nor the directions of association could be determined.

INTRODUCTION

Diabetes is a common chronic condition affecting 9% of the world population[1]; it is a major cause of morbidity and mortality, and poses a significant challenge for public health systems globally with its increasing prevalence.[2] The WHO estimated that, in 2014, there were 422 million people living with diabetes.[3] People with diabetes not only experience an increased risk of microvascular and macrovascular complications and reduced life expectancy,[4][5] but also have reduced physical functioning, social interactions and cognitive status.[6–8]

Psychological distress is approximately two times more prevalent in people with diabetes than people without diabetes.[9][10] Concomitant psychological distress and diabetes have

been associated with poor glycaemic control, increasing disabilities, loss of productivity and all-cause mortality.[11–14] Psychological distress is also increased—to an even greater extent—in people living with Physical Functional Limitations (PFLs).[15 16] It is unclear how much of the elevation of psychological distress in people with diabetes is attributable to their higher levels of physical disability. Although many studies have focused on the association between psychological distress and diabetes,[9 10 17] there is a lack of reliable evidence on how PFLs affect the association between psychological distress and diabetes. Using a large population-based survey of Australian adults, this study aimed to quantify: (1) the relation of psychological distress to diabetes and (2) the separate and combined associations of diabetes and PFLs with psychological distress, accounting for potential confounding factors.

RESEARCH DESIGN AND METHODS
Study population
The Sax Institute's 45 and Up Study is a population-based cohort study of over 266000 people aged 45 and over in New South Wales, the most populous state of Australia. Individuals joined the study by completing a postal questionnaire distributed between 1 January 2006 and 31 December 2008.[18] The Department of Human Service (formerly Medicare Australia) mailed questionnaires and information leaflets (available at http://www.45andUp. org.au) to chosen participants in its database. The participants completed the questionnaires. There was a twofold oversampling of people aged 80 years and above and those who lived in rural areas. The overall response rate was 18%, not dissimilar to other longitudinal studies.[19] Cross-sectional analysis of baseline questionnaire data was used in this study.

Participant involvement
Participants in the 45 and Up Study receive an annual newsletter informing them of the study progress and projects under way using the study data. The study website is also kept up to date regarding research under way and events. There is no individual feedback to study participants regarding findings or results specific to that individual.

Study measures
The outcome was psychological distress measured using the Kessler Psychological Distress Scale (K10). The K10 is a validated measure of non-specific symptoms of psychological distress such as feeling 'hopeless' or 'depressed'.[20] Respondents indicated on a five-point scale, the frequency they experienced each of the symptoms in the past 4 weeks, ranging from 1 'none of the time' to 5 'all of the time'. Scores range from 10 (no distress) to 50 (severe distress); scores were grouped as low (10 to <16), moderate (16 to <22), high (22 to <30) and severe psychological distress (30–50).[21] In regression models,

high psychological distress was defined as a binary variable (K10 score 22–50).

The main exposure in this study was self-reported diabetes. A participant's diabetes status was identified by his/her answer to the question: 'Has a doctor EVER told you that you have [a number of diseases were listed, including diabetes]?'. The period for which a participant had diabetes was calculated using the participant's reported age at the recruitment into the study and the participant's age when he/she reported being diagnosed with diabetes. This measure has been shown to be 98% valid, when compared with medical/prescribing records.[22]

PFLs were assessed using the Physical Functioning subscale of the Medical Outcomes Study.[23] Respondents reported whether they were 'limited a lot', 'a little' or 'not limited at all' when performing a list of 10 activities, ranging from 'vigorous activities' to 'bathing or dressing'. Scores ranged from 0 to 100, where higher scores represented fewer limitations, and were grouped into four categories: severe (0–59); moderate (60-74), minor (75-99) and no (100) functional limitations. Additionally, participants were asked 'do you regularly need help with daily tasks because of long-term illness or disability?'. Those who answered yes were considered to have severe disabilities.

Covariates considered in this study were age, sex, education, area of residence and country of birth. Participants were categorised into the following 10-year age groups: 45–54, 55–64, 65–74, 75–84 and >85 years. Education was categorised as follows: no educational qualifications, certificate/diploma/school and university education. Area of residence was categorised based on the Accessibility and Remoteness Index of Australia (ARIA+) into major cities, inner regional and more remote areas. Country of birth was categorised into five groups: Australia/New Zealand, Europe/North America, Asia, Africa/Middle-East and other. The other risk factors investigated in the study were annual household income, alcohol consumption per week, smoking status, private health insurance, four categories body mass index (as per the WHO classification, with all types of obesity categorised into one category),[24] use of language other than English and medical history (cardiovascular diseases, cancer and anxiety/depression).

Participants were included in this study if they had valid data for diabetes status and psychological distress. Of the 266777 participants, 30336 (11%) who have invalid or missing K-10 scores were excluded from the analysis. There were no missing data for diabetes status. Following exclusions, 236441 participants were eligible to be included in the analysis.

Statistical methods
The sociodemographic and health behaviour characteristics of the study population were summarised for those with and without diabetes. Patterns of psychological distress in people with and without diabetes were

summarised using percentages and Fisher's exact confidence intervals (CIs.[25] Prevalence ratios (PRs) and 95% CIs for psychological distress, in those with versus without diabetes, were estimated using modified Poisson regression with robust error variance. How much of any observed relationship could be attributed to disability was evaluated by estimating PRs comparing those with and without diabetes, and across categories of diabetes duration, stratified by level of PFL and need for help with daily tasks. Models were initially adjusted for age and sex (model 1) and then further adjusted for education, area of residence, country of birth (model 2). Nested regression models investigated further adjustment for smoking status, alcohol consumption per week in addition to covariates in model 2 (model 3); need for help in daily tasks and PFL in addition to covariates in model 3 (model 4 and model 5, respectively). Missing values in covariates were modelled as a separate category. Tests for trend were performed by modelling the exposure categories as an ordinal variable.

Sensitivity analyses were conducted by adjusting the analyses additionally for other variables such as smoking status, alcohol consumption and disability in the regression model to determine if other factors affected the association between psychological distress and diabetes. A complete case analysis was performed to determine whether the approach to missing data influenced the association. All statistical analyses used a significance level of 5%. Analyses were performed using Stata V.14.

RESULTS

Of the total study population, 19 803 (8.4%) participants reported having diagnosed diabetes. The prevalence of diabetes was higher among: males, older age groups, those born in countries other than Australia, those who spoke languages other than English at home, those with lower education levels, those with lower annual household income, those with no private health insurance, the obese, ex-smokers, those reporting comorbidities such as cardiovascular diseases, cancer (other than skin cancer) and anxiety/depression (table 1). Among those with diabetes, the mean duration of diabetes was 7.7 years; 12%, 42% and 36% were diagnosed in the past <2 years, 2–10 years and >10 years, respectively.

The crude prevalence of *severe* psychological distress (K10 30–50) was twice as high among those with versus without diabetes (4.1% vs 2.0%; table 2). High psychological distress (K10 22–50, combining 'severe' and 'high' distress categories) was greater among participants with versus without diabetes (11.8% vs 7.2%, table 2). The pattern of high psychological distress among those with versus without diabetes remained regardless of the duration of diabetes; PRs (95% CI) were 1.60 (1.44 to 1.79), 1.65 (1.55 to 1.75) and 1.84 (1.72 to 1.96) for duration of diabetes <2 years, 2–10 years and >10 years, respectively (figure 1).

Table 1 Prevalence of diabetes according to baseline characteristics in the study population

	Prevalence of diabetes (%)	N with diabetes/total
Overall	8.4	(19 803/236 441)
Age group (years)		
45–54	4.5	(3344/74 969)
55–64	7.9	(6292/79 571)
65–74	12.0	(5947/49 446)
75–84	13.4	(3655/27 195)
85+	10.7	(565/5260)
Sex		
Males	10.3	(11 431/111 242)
Females	6.7	(8372/125 199)
Education		
No school certificate	13.4	(3262/24 334)
Certificate/diploma/trade	8.5	(12 794/150 411)
Tertiary	5.8	(3392/58 768)
Annual household income		
<$20 000	14.2	(6030/42 578)
$20 000 to <$40 000	9.5	(3933/41 566)
$40 000 to <$70 000	6.5	(2893/44 232)
$70 000+	4.7	(2844/60 811)
Region of residence		
Major cities	8.4	(8976/106 533)
Inner regional	8.4	(6997/83 472)
More remote	8.3	(3829/46 385)
Country of birth		
Australia and New Zealand	8.0	(14 572/182 755)
Europe/North America	9.0	(3435/38 145)
Asia	11.9	(956/8055)
Africa/Middle East	11.8	(469/3964)
Other	10.6	(202/1902)
Private health insurance		
No private health insurance	11.0	(8591/78 156)
Health insurance	7.1	(11 212/158 282)
Language other than English at home		
No	8.0	(17 283/214 860)
Yes	11.7	(2520/21 579)
Smoking status		
Never smoker	8.2	(9724/132 917)
Past smoker	10.0	(8578/85 472)
Current smoker	7.3	(1432/17 371)
Alcohol consumption, drinks/week		
0	12.1	(8988/74 137)
1–14	6.5	(8068/124 205)

Continued

Table 1 Continued

	Prevalence of diabetes (%)	N with diabetes/ total
15+	6.6	(2276/34 583)
Body mass index		
Underweight	3.9	(98/2521)
Normal weight	4.5	(3596/80 654)
Overweight	7.8	(6799/87 430)
Obese	15.7	(7707/49 121)
Medical history: CVD		
No	4.7	(6942/146 468)
Yes	14.3	(12 861/89 973)
Medical history: cancer		
No	8.0	(15 956/200 107)
Yes	10.6	(3847/36 334)
Medical history: anxiety or depression		
No	8.2	(13 500/165 594)
Yes	9.8	(3808/38 929)
PFL based on MOS-PF score*		
No limitation (100)	4.4	(3278/74 580)
Minor limitation (75-99)	6.8	(4270/62 659)
Moderate limitation (60-74)	10.8	(5432/50 418)
Severe limitation (0-59)	18.8	(4832/25 646)
Needing help with daily task		
No	7.7	(16 654/216 069)
Yes	20.9	(2338/11 173)

The percentage of missing data (%): 2928 (1.24%) for education, 3 (<0.01%) for health insurance, 47 254 (20%) for income, 51 (0.02%) for area of residence, 1620 (0.69%) for country of birth, 2 (<0.01%) for language other than English at home, 681 (0.29%) for smoking status, 3516 (1.49%) for alcohol consumption, 16 715 (7.07%) for body mass index, 1987 (10.03%) of diabetes duration, 31 918 (13.5%) for anxiety and depression, 23 138 (9.79%) for MOS-PF and 9199 (3.89) need help with daily task.
*MOS-PF, Physical Functioning subscale of the Medical Outcomes Study; PFL, physical functional limitation.

Stratification based on participants' diabetes status and PFLs showed that a substantial portion of this elevation in psychological distress among those with diabetes is attributable to higher levels of PFLs (figure 1). Compared with participants without diabetes or PFLs, the PRs of high psychological distress were 1.35 (95% CI 1.28 to 1.42), 2.84 (95% CI 2.71 to 2.98) and 7.33 (95% CI 7.00 to 7.67) among those without diabetes and with minor, moderate or severe PFLs, respectively. There was a 37% higher prevalence of high psychological distress in participants with diabetes, but no PFL. In the presence of both diabetes and PFL, the prevalence of high psychological distress was higher compared with participants without diabetes; PRs 1.65 (95% CI 1.44 to 1.89), 3.52 (95% CI 3.22 to 3.85) and 8.89 (95% CI 8.36 to 9.46) among those with minor, moderate and severe PFLs, respectively (figure 1).

Stratification based on participants' diabetes status and severe disability (needing help with daily tasks) showed that psychological distress is much more strongly related to severe disability than diabetes (figure 1). Compared with participants without diabetes or severe disability, the PR for psychological distress was: 4.80 (95% CI 4.61 to 4.99) in participants with severe disability only, 1.55 (95% CI 1.47 to 1.64) in participants with diabetes only and 5.78 (95% CI 5.44 to 6.14) in those with both diabetes and severe disability.

The PR for high psychological distress among those with versus without diabetes attenuated with further sequential adjustment for sociodemographic characteristics and health behaviours, but remained significantly elevated (PR 1.89 (95% CI 1.81 to 1.97) in model 1 to 1.58 (1.52 to 1.65) in model 3; figure 2). Further adjustment for needing help with daily tasks (model 4, 1.35, 1.29 to 1.40) or PFLs (model 5, 1.22, 1.17 to 1.27) further attenuated the PR.

CONCLUSIONS

In this large population-based study, the prevalence of psychological distress was moderately elevated in people

Table 2 Patterns of psychological distress among people with and without diabetes

Psychological distress level	N with diabetes/total	Prevalence in those with diabetes (%)	Prevalence in those without diabetes (%)
Low psychological distress	13 946/181 052	70.4 (69.8 to 71.1)	77.1 (77.0 to 77.3)
Moderate psychological distress	3518/37 386	17.8 (17.2 to 18.3)	15.6 (15.5 to 15.8)
High psychological distress	1533/12 794	7.7 (7.4 to 8.1)	5.2 (5.1 to 5.3)
Severe psychological distress	806/5209	4.1 (3.8 to 4.4)	2.0 (2.0 to 2.1)

K10 scores for psychological distress were grouped as low (10 to <16), moderate (16 to <22), high (22 to <30) and severe psychological distress (30 to 50).
95% CIs are based on Fisher's exact method.

	N	High PD	PR[1] (95% CI)	PR[2,3] (95% CI)	
Diabetes duration (n= 234,454)					
No diabetes	216638	7.2%	1	1	
Diabetes for less than 2 years	2461	11.7%	1.74 (1.56-1.94)	1.60 (1.44-1.79)	
Diabetes for 2-10 years	8310	11.3%	1.78 (1.68-1.90)	1.65 (1.55-1.75)	
Diabetes for more than 10 years	7045	12.2%	2.01 (1.89-2.15)	1.84 (1.72-1.96)	
PFL and diabetes (n= 213,303)					
No diabetes and no PFL	71302	3.9%	1	1	
No diabetes and minor PFL	58389	4.4%	1.33 (1.27-1.41)	1.35 (1.28-1.42)	
No diabetes and moderate PFL	44986	8.5%	2.92 (2.79-3.07)	2.84 (2.71-2.98)	
No diabetes and severe PFL	20814	21.4%	8.01 (7.70-8.42)	7.33 (7.00-7.67)	
Diabetes and no PFL	3278	4.9%	1.46 (1.25-1.70)	1.37 (1.17-1.60)	
Diabetes and minor PFL	4270	4.8%	1.70 (1.48-1.95)	1.65 (1.44-1.89)	
Diabetes and moderate PFL	5432	9.6%	3.76 (3.44-4.11)	3.52 (3.22-3.85)	
Diabetes and severe PFL	4832	24.8%	10.11 (9.51-10.75)	8.89 (8.36-9.46)	
NHDT and diabetes (n= 227,242)					
No diabetes and no NHDT	199415	6.1%	1	1	
No diabetes and NHDT	8835	28.5%	5.42 (5.22-5.63)	4.80 (4.61-4.99)	
Diabetes and no NHDT	16654	8.6%	1.66 (1.58-1.75)	1.55 (1.47-1.64)	
Diabetes and NHDT	2338	33.5%	6.86 (6.47-7.28)	5.78 (5.44-6.14)	

Figure 1 Prevalence ratio of high PD (K10 score 22–50) by duration of diabetes, physical functional limitation and the need for help with daily tasks. [1]PR of PD adjusted for age and sex. [2]PR of PD adjusted for age, sex, education, area of residence and country of birth [3]Test for p-trend for each strata showed significant result (p<0.000). NHDT, need for help with daily tasks; PD, psychological distress; PFL, physical functioning limitation; PR, prevalence ratio.

with diabetes versus those without diabetes; a substantial part of this elevation was attributable to higher levels of physical disability. It was shown that the prevalence of psychological distress was seven to eight times higher when participants had severe PFLs regardless of their
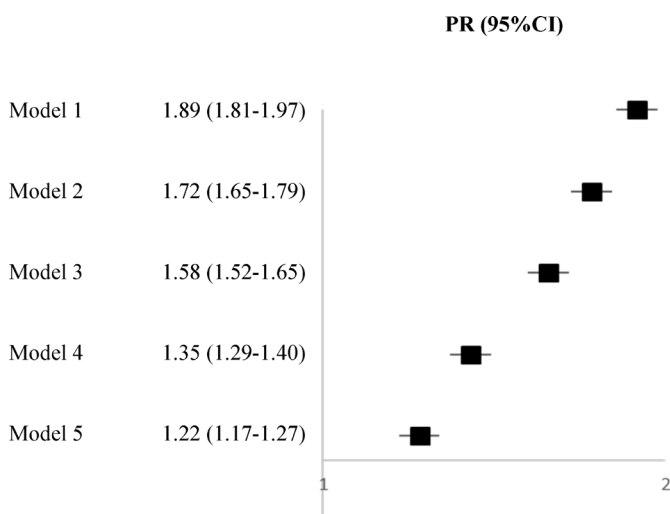
PR (95%CI)

Model 1	1.89 (1.81-1.97)
Model 2	1.72 (1.65-1.79)
Model 3	1.58 (1.52-1.65)
Model 4	1.35 (1.29-1.40)
Model 5	1.22 (1.17-1.27)

Figure 2 Nested regression models showing the attenuation in prevalence ratio (PR) for high psychological distress in people with versus without diabetes, with further adjustment for confounders. Model 1: adjusted for age and sex; model 2: model 1 is adjusted further for education, area of residence and country of birth; model 3: model 2 is adjusted further for alcohol drink per week and smoking status; model 4: model 3 is adjusted further for need for help with daily tasks; model 5: model 3 is adjusted further for physical functioning limitation.

diabetes status. The prevalence of psychological distress was four to six times higher when participants had severe disability regardless of their diabetes status. The excess prevalence of psychological distress attributable to severe PFLs and disability were around 20 times greater and seven times greater, respectively, than those attributable to diabetes alone. Importantly, the point estimate for the relation of diabetes to psychological distress attenuated by >60% when further adjusted for PFL; considering that each factor is measured with some degree of error, this means that PFL accounts for the bulk of the observed diabetes–psychological distress relationship.

Previous studies have shown similar mediation by PFL in the association between psychological distress and other disease outcomes, such as heart disease, arthritis and cancer.[26 27] The excess risk of psychological distress attributable to disability is about 40 times greater on average than that attributable to cancer diagnosis, in the absence of disability, among long-term cancer survivors.[26] Further, the risk of depression in those with arthritis or heart disease was shown to attenuate when activities of daily living and instrumental activities of daily living limitation were considered, demonstrating that physical limitation mediates, to some extent, the association between depression and these conditions.[27]

The findings suggest that functional limitation and disability may mediate the development of psychological distress among those with underlying chronic illness, including diabetes. Depression and physical functioning have been shown to interact with each other in a dynamic

way, in people with type 2 diabetes; depression at one assessment point might predict poor functioning at the next assessment point which in turn might predict depression at the next assessment point.[28] Macro and micro vascular diabetes complications such as strokes, peripheral artery diseases, coronary artery diseases, retinopathy and neuropathy may limit people in their physical functioning including self-care.[11 29] Greater disease severity, disability and self-care burden in turn increase psychological distress in people with diabetes.[30 31]

Attenuation in PRs following adjustments for sociodemographic characteristics and health behaviours are consistent with previous findings. Studies conducted in the USA and Australia have showed other risk factors such as sociodemographic factors, health behaviours and diet attenuated the association between psychological distress and diabetes by 30%–80%.[9 32] In this study, the association between diabetes and distress was 54% lower when adjusted for PFLs and 67% lower when adjusted for disability.

Limitations and strengths

This study was conducted using data from the 45 and Up Study (the largest health research study in Australia). The large size of the population of the study and the wide range of health data collected from the study population has allowed for multiple variables to be adjusted for. The study questionnaire used validated measures of psychological distress and PFLs which ensured the reliability of the data.

The findings in this study are subject to some limitations. First, diabetes was determined using self-report. However, a previous study has shown both high sensitivity and specificity for self-reported diabetes in this population, with 98% of true cases being correctly identified.[22] Second, the absolute estimates of prevalence in this study may not be representative of the population. However, PRs are based on internal comparisons and remain valid in non-representative cohort studies.[33 34] Third, the use of a cross-sectional design meant that neither the causality nor the directions of association could be determined. However, there is growing recognition that the complications associated with type 2 diabetes may translate into functional impairment in older people.[35] Further, since psychological distress is unlikely to substantively cause diabetes and since the relationship of PFL to distress is well established, having been largely established in other studies, the findings of this study are likely to largely reflect causal associations[28] between psychological distress and PFL.

In conclusion, the prevalence of high psychological distress is moderately elevated in people with diabetes; a substantial part of this elevation is attributable to physical disability. Other sociodemographic characteristics and health behaviours appear to mediate the association between psychological distress and diabetes. Although causal relationships cannot be established definitively using these data, diabetes management guidelines are likely to benefit from prevention and prompt treatment of diabetes complications which contribute to PFL and disabilities, as well as the identification and effective management of psychological distress.

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